PATENT ABSTRACTS OF JAPAN

(11)Publication number : **06-103550**
(43)Date of publication of application : **15.04.1994**

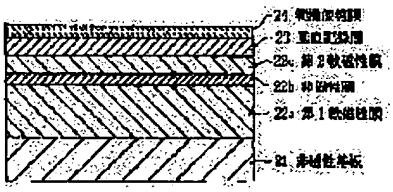
(51)Int.CI. **G11B 5/66**

(21)Application number : **04-249749**
(22)Date of filing : **18.09.1992**

(71)Applicant : **FUJITSU LTD**
(72)Inventor : **KIKUCHI AKIRA**
IWAFUNE HITOMI
WAKAMATSU HIROAKI

(54) PERPENDICULAR MAGNETIC RECORDING MEDIUM

(57)Abstract:
PURPOSE: To enhance magnetic characteristics by forming a thin film having the same crystal structure as that of a perpendicular recording layer and crystal orientability in a perpendicular direction and made of a material different from the material of a 1st soft magnetic film as the 1st layer and that of a 2nd soft magnetic film as the 3rd layer as the 2nd layer.
CONSTITUTION: A soft magnetic backing layer having a three-layered structure and a perpendicular recording layer 23 are successively laminated by sputtering. The growth of the grains of a 2nd soft magnetic film 22c formed on a nonmagnetic film 22b having the same crystal structure as the recording layer 23 and crystal orientability in a perpendicular direction is inhibited, the perpendicular recording layer 23 formed on the 2nd soft magnetic film 22c has satisfactory crystal orientability in the perpendicular direction and a high coercive force from its initially grown layer and the magnetic characteristics of the recording layer 23 are enhanced.



LEGAL STATUS

[Date of request for examination]

[Date of sending the examiner's decision of rejection]

[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]

[Date of final disposal for application]

[Patent number]

[Date of registration]

[Number of appeal against examiner's decision of rejection]

[Date of requesting appeal against examiner's decision of rejection]

[Date of extinction of right]

* NOTICES *

1. This document has been translated by computer.So the translation may not reflect the original precisely.
2. **** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]
[Claim 1] In the vertical-magnetic-recording medium which comes to carry out the laminating of a soft-magnetism backing layer and the vertical recording layer (23) to order on a nonmagnetic substrate (21) About the aforementioned soft-magnetism backing layer, they are the 1st soft-magnetism film (22a) and a nonmagnetic membrane (22b) from this substrate side. It reaches and is the 2nd soft-magnetism film (22c). It considers as 3 lamination which carried out the laminating, and is this 2nd soft-magnetism film (22c). It is thickness 0.3 Vertical-magnetic-recording medium characterized by carrying out to below mum.
[Claim 2] Nonmagnetic membrane which constitutes the aforementioned soft-magnetism backing layer (22b) Vertical-magnetic-recording medium of the claim 1 characterized by having the same crystal structure as a vertical recording layer (23), and vertical crystal orientation, and setting the thickness to 0.04 micrometers or less.
[Claim 3] Nonmagnetic membrane which constitutes the aforementioned soft-magnetism backing layer (22b) Vertical-magnetic-recording medium of the claim 1 characterized by the bird clapper from an amorphous-like nonmagnetic membrane.
[Claim 4] Nonmagnetic membrane which constitutes the aforementioned soft-magnetism backing layer (22b) The 1st soft-magnetism film instead formed of oxygen plasma treatment (32a) Oxide surface layer (32b) Vertical-magnetic-recording medium of the claim 1 characterized by preparing.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] this invention relates to the vertical-magnetic-recording medium used for the magnetic disk unit of a perpendicular magnetic recording method, especially relates to the suitable vertical-magnetic-recording medium for the formation of high-density record.
[0002] In recent years, large-capacity-izing, a miniaturization, etc. of a magnetic disk unit are demanded by increase of the amount of information processing in a computer system. the record medium of the perpendicular magnetic recording method whose high-density record is enabled more in a magnetic-recording medium compared with the record medium of the conventional level magnetization recording method in connection with it -- namely, -- high -- on the permeability soft-magnetism backing layer, the vertical-magnetic-recording medium of the bilayer membrane structure which carried out the laminating of the vertical recording layer which has a perpendicular magnetic anisotropy is proposed, and utilization is advanced
[0003] Although it is desirable to form a soft-magnetism backing layer and the vertical recording layer prepared on it according to the same thin film formation processes, such as the sputtering method, from a viewpoint of productivity as for such a vertical-magnetic-recording medium, in order that it may raise a record regeneration efficiency, when thickness of a soft-magnetism backing layer is thickened, it is in the inclination for the magnetic properties (coercive force) of a vertical recording layer to fall. For this reason, the fall of the magnetic properties of such a vertical recording layer is suppressed, and the medium structure of raising record reproducing characteristics is needed.
[0004]
[Description of the Prior Art] The conventional vertical-magnetic-recording medium on the nonmagnetic substrate 11 which consists of an aluminum substrate which performed surface treatment, such as NiP plating, as shown in the important section cross section of drawing 4 , or a glass substrate by the sputtering method or the galvanizing method for example, it consists of a NiFe film of about 1-micrometer thickness -- high -- it consisted of composition which carried out the laminating of the permeability soft-magnetism backing layer 12 and the vertical recording layer 13 which consists of a CoCr film of about 0.15-micrometer thickness to order, and the lubricous protective coat is covered on the front face of this vertical recording layer 13 if needed
[0005] And the record magnetic field from the perpendicular magnetic head which performs record and reproduction to the vertical-magnetic-recording medium of this composition magnetizes the aforementioned vertical recording layer 13 perpendicularly, and is passed. Information record is performed by the magnetic circuit which passes this vertical recording layer 13 perpendicularly again horizontally through the aforementioned soft-magnetism backing layer [directly under] 12 of it, and returns to the aforementioned perpendicular magnetic-head side. Moreover, the main pole of the perpendicular magnetic head which received the record magnetic field from the already recorded aforementioned vertical recording layer 13 is magnetized, and it is reproducing by taking out the voltage produced in the coil interlinked with the main pole as a regenerative signal.
[0006]
[Problem(s) to be Solved by the Invention] By the way, in the above-mentioned vertical-magnetic-recording medium of a bilayer membrane structure, although the aforementioned soft-magnetism backing layer 12 is formed by the sputtering method or the galvanizing method and the vertical recording layer 13 is forming membranes by the sputtering method, in order to obtain such a vertical-magnetic-recording medium or the vertical-magnetic-recording medium of the minor diameter by miniaturization with sufficient productivity, it is desirable to form the aforementioned soft-magnetism backing layer and a vertical recording layer according to the same thin film formation process.
[0007] Moreover, good high-density record reproducing characteristics (a reproduction output, resolution) In order to raise the record regeneration efficiency in the magnetic-circuit system which improvement in the magnetic properties of a soft-magnetism backing layer and a vertical recording layer is indispensable, and is further constituted by the combination of the vertical-magnetic-recording medium and the perpendicular magnetic head concerned in order to obtain, it is desirable to make thickness of the aforementioned soft-magnetism backing layer as thick as possible.
[0008] However, when forming this soft-magnetism backing layer by the sputtering method, the problem that the coercive force (Hc) of the vertical recording layer prepared on the soft-magnetism backing layer according to the increase in the thickness as a white round mark showed drawing 3 declines arises.
[0009] Crystal grain grows, the surface state of this soft-magnetism backing layer becomes bad, and such a phenomenon is considered because the holding power of the initial layer of growth of the vertical recording layer prepared on the

soft-magnetism backing layer originates in a bird clapper small as the thickness increases at the time of membrane formation of a soft-magnetism backing layer. Furthermore, since the magnetic perpendicular stacking tendency of this vertical recording layer was also bad, there was a problem that record reproducing characteristics deteriorated -- the writing nature and the reproduction output of the magnetic-recording medium concerned decline.

[0010] On the other hand, in order to solve such a problem, the composition between which nonmagnetic Ti layer which has a crystal stacking tendency perpendicular to the same crystal structure as this vertical recording layer was made to be placed between a soft-magnetism backing layer and a vertical recording layer is proposed. However, the interval at the soft-magnetism backing layer at the time of record and reproduction and the nose of cam of a magnetic pole of the perpendicular magnetic head spread by the thickness, and the gap loss in record reproducing characteristics became large, and making such a nonmagnetic Ti layer intervene had the problem that a record regeneration efficiency fell.

[0011] this invention aims at offering the new vertical-magnetic-recording medium which prepared the vertical recording layer which is high coercive force, without producing gap loss with the perpendicular magnetic head, and was excellent in the perpendicular stacking tendency, and aimed at improvement in magnetic-recording reproducing characteristics on the soft-magnetism backing layer thickly formed by the sputtering method excellent in productivity etc. in view of the above-mentioned conventional trouble.

[0012]

[Means for Solving the Problem] the vertical-magnetic-recording medium which comes to carry out the laminating of a soft-magnetism backing layer and the vertical recording layer to order on a nonmagnetic substrate in order that this invention may attain the above-mentioned purpose -- setting -- the aforementioned soft-magnetism backing layer -- this substrate side -- the [the 1st soft-magnetism film, a nonmagnetic membrane, and] -- 3 lamination which carried out the laminating of the 2 soft-magnetism films -- carrying out -- the thickness of this 2nd soft-magnetism film -- 0.3 It considers as the composition made below into mum.

[0013] Moreover, the nonmagnetic membrane which constitutes the aforementioned soft-magnetism backing layer has the crystal stacking tendency of the same crystal structure as a vertical recording layer, and a perpendicular direction, and considers as the composition which set the thickness to 0.04 micrometers or less. Furthermore, it considers as the composition which prepared the oxide surface layer of the 1st soft-magnetism film formed of oxygen plasma treatment instead of the nonmagnetic membrane which constitutes the aforementioned soft-magnetism backing layer being an amorphous-like nonmagnetic membrane or its nonmagnetic membrane.

[0014]

[Function] At this invention, it is this nonmagnetic substrate side about a soft-magnetism backing layer. 0.5-2.0 By the 1st soft-magnetism film which consists of a NiFe film of the same thickness as the former of mum, and thickness 0.04 micrometers or less And Ti film which has the crystal stacking tendency of the same crystal structure as a vertical recording layer, and a perpendicular direction, Or it considers as 3 lamination which carried out the laminating of the 2nd soft-magnetism film which consists of a nonmagnetic membrane which consists of an amorphous-like carbon film, and a NiFe film of thickness 0.30 micrometers or less. By considering as the composition which carried out the laminating of the soft-magnetism backing layer and vertical recording layer of the 3 lamination to order by the sputtering method Grain growth of the crystal grain of the 2nd soft-magnetism film prepared on the aforementioned nonmagnetic membrane which has the crystal stacking tendency of the same crystal structure as a vertical recording layer and a perpendicular direction is suppressed, from the initial layer of growth, the vertical recording layer arranged on this 2nd soft-magnetism film has the crystal stacking tendency and high coercive force of a good perpendicular direction, and its magnetic properties of the improve.

[0015] Moreover, since the aforementioned nonmagnetic membrane is very thin and a magnetic interaction works between the 1st soft-magnetism film and the 2nd soft-magnetism film, the ********** of the whole soft-magnetism backing layer of 3 lamination does not fall. Since neither the magnetic reluctance of the nonmagnetic membrane nor the record regeneration efficiency in the magnetic-circuit system constituted by the combination of the vertical-magnetic-recording medium and the perpendicular magnetic head concerned since it does not act as series resistance directly falls, the vertical-magnetic-recording medium which improved is obtained.

[0016] Furthermore, the vertical-recording layer which improved is obtained, and the vertical-magnetic-recording medium which improved can obtain similarly by considering as the composition which processed the front face of the 1st soft-magnetism film with oxygen plasma, and prepared the oxide surface layer of this formed 1st soft-magnetism film instead of the nonmagnetic membrane which constitutes the aforementioned soft-magnetism backing layer.

[0017]

[Example] The example of this invention is explained in detail using a drawing below. Drawing 1 is the important section cross section showing one example of the vertical-magnetic-recording medium concerning this invention.

[0018] It is the nonmagnetic substrate which consists of an aluminum substrate which the hole was prepared and performed surface treatment, such as NiP plating, or a glass substrate. drawing -- setting -- 21 -- a center -- support -- by the sputtering method on this nonmagnetic substrate 11 For example, 0.5-2.0 1st soft-magnetism film 22a which consists of a NiFe film of the thickness of mum By 0.005-0.03-micrometer thickness And Ti film which has the same crystal structure as the vertical recording layer 23 mentioned later, and its perpendicular stacking tendency, Or nonmagnetic membrane 22b which consists of an amorphous-like carbon film 2nd soft-magnetism film 22c which consists of a NiFe film of 0.05-0.30-micrometer thickness The soft-magnetism backing layer of 3 lamination which carried out the laminating to order is prepared. Soft-magnetism backing layer top, i.e., 2nd soft-magnetism film, 22c It is further 0.1-0.2 upwards. It is considering as the composition which formed the

vertical recording layer 23 which consists of a CoCrTa film of the thickness of mum. In addition, the lubricous protective coat 24 is covered on the front face of the vertical recording layer 23 if needed.
[0019] Nonmagnetic membrane 22b of the thin thickness which has the same crystal structure as the vertical recording layer 23 in the aforementioned soft-magnetism backing layer, and its perpendicular stacking tendency by such vertical-magnetic-recording medium of composition As the trigonum mark shows to the vertical crystal stacking tendency and vertical drawing 3 in which the vertical recording layer 23 on this soft-magnetism backing layer was excellent from the initial layer of growth with existence, it has high coercive force and becomes, and the magnetic properties improve.
[0020] moreover, aforementioned nonmagnetic membrane 22b very -- thin -- 1st soft-magnetism film 22a in order that a magnetic interaction may work between 2nd soft-magnetism film 22c, the ********** of the whole soft-magnetism backing layer also falls -- since -- the vertical-magnetic-recording medium which improved is obtained -- things can be carried out
[0021] in addition, as a method of manufacturing the vertical-magnetic-recording medium of composition of having described above On the aforementioned nonmagnetic substrate 21, the power density of the supply voltage for spatters 4 - 8 W/cm2, ********** -- 5 - 10mTorr and substrate temperature the sputtering method by the spatter conditions made into 150-200 ** -- 0.5-2.0 1st soft-magnetism film 22a which consists of a NiFe film of the thickness of mum The 1st soft-magnetism film 22a Upwards the power density of the supply voltage for spatters 2 - 5 W/cm2, ********** -- 5 - 10mTorr and substrate temperature Nonmagnetic membrane 22b which consists of a Ti film of 0.005-0.03-micrometer thickness by the sputtering method by the spatter conditions made into 150-200 ** Nonmagnetic membrane 22b Upwards the power density of the supply voltage for spatters 2 - 5 W/cm2, They are 5 - 10mTorr and substrate temperature about **********. 2nd soft-magnetism film 22c which consists of a NiFe film of 0.05-0.30-micrometer thickness by the sputtering method by the spatter conditions made into 150-200 ** It forms in order. The power density of the supply voltage for spatters on the soft-magnetism backing layer of this 3 lamination 2 - 6 W/cm2, They are 5 - 20mTorr and substrate temperature about **********. It is 0.1-0.2 by the sputtering method by the spatter conditions made into 150-250 **. The vertical recording layer 23 which consists of a CoCrTa film of the thickness of mum is formed. The desired vertical-magnetic-recording medium shown in drawing 1 can be obtained by covering the lubricous protective coats 24, such as a spatter carbon film, on the front face of the aforementioned vertical recording layer 23 further if needed.
[0022] Drawing 2 is the important section cross section showing other examples of the vertical-magnetic-recording medium concerning this invention, and gives the same sign to drawing 1 and the equivalent portion. The point that the example shown in this drawing differs from the example shown by drawing 1 About the nonmagnetic membrane which constitutes a soft-magnetism backing layer, it is 1st soft-magnetism film 32a. This 1st soft-magnetism film 32a which processed the front face with oxygen plasma and was formed Oxide surface-layer 32b It is in the point replaced with. In this case, this oxide surface-layer 32b Thickness can be easily formed in a 100 ** grade very thinly from several 10A, and it becomes advantageous from the field of a magnetic-recording regeneration efficiency.
[0023] By composition of this example as well as the example by aforementioned drawing 1 , in the vertical crystal stacking tendency and vertical drawing 3 which were excellent from the initial layer of growth, the vertical recording layer 23 has high coercive force, as the square mark shows, and its magnetic properties of the improve. Moreover, since the ********** of the whole soft-magnetism backing layer does not fall, either, the vertical-magnetic-recording medium which improved is obtained, and the thing of it can be carried out.
[0024] In addition, it will not be limited, especially if an aluminum substrate or substrates other than a glass substrate, such as a ceramic, may be used and the material of each class, such as the 1st soft-magnetism film, the 2nd soft-magnetism film, and a vertical recording layer, can also achieve each function as a nonmagnetic substrate. Furthermore, it is not limited to an example about the formation conditions of each class.
[0025]
[Effect of the Invention] According to the vertical-magnetic-recording medium concerning this invention, so that clearly from the above explanation By preparing the thin film of material which makes a soft-magnetism backing layer 3 lamination, and has the crystal stacking tendency of a vertical recording layer, the same crystal structure, and a perpendicular direction in the 2nd layer, and is different from the 1st soft-magnetism film of the 1st layer, and the 2nd soft-magnetism film of the 3rd layer Grain growth of the crystal grain of the 2nd soft-magnetism film prepared on the thin film of eye this 2nd layer is suppressed, from the initial layer of growth, the vertical recording layer arranged on this 2nd soft-magnetism film has the crystal stacking tendency and high coercive force of a good perpendicular direction, and its magnetic properties of the improve.
[0026] Moreover, the thin film of the 2nd aforementioned layer is very thin, and since the ********** of the whole soft-magnetism backing layer does not fall, either, in order that a magnetic interaction may work between the 1st soft-magnetism film and the 2nd soft-magnetism film, it has the outstanding advantage which can realize easily the vertical-magnetic-recording medium which improved.
[0027] Therefore, practical effects -- since each class can be formed by the same membrane formation meanses, such as the sputtering method, productivity improves, and it applies to the small vertical-magnetic-recording medium of especially a minor diameter, and low-cost-ization can be realized -- are large.

[Translation done.]